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CONTINUING (1.53(b)) UTILITY PATENT APPLICATION TRANSMITTAL (Only for continuing applications under 37 CFR 1.53(b))		Attorney Docket No. 1293.1076D/STB	
		First Named Inventor: Jin-gyo SEO, et al.	
		Title:	ADAPTIVE WRITING METHOD FOR HIGH-DENSITY OPTICAL RECORDING APPARATUS AND CIRCUIT THEREOF
		Express Mail Label No.	

APPLICATION ELEMENTS See MPEP chapter 600 concerning utility patent application contents.	ADDRESS TO: Assistant Commissioner for Patents Box Patent Application Washington, DC 20231
<p>1. <input checked="" type="checkbox"/> Fee Transmittal Form</p> <p>2. <input checked="" type="checkbox"/> Specification, Claims & Abstract [Total Pages: <u>17</u>]</p> <p>3. <input checked="" type="checkbox"/> Drawing(s) (35 USC 113) [Total Sheets: <u>7</u>]</p> <p>4. <input checked="" type="checkbox"/> Oath or Declaration [Total Pages: <u>3</u>] a. <input type="checkbox"/> Newly executed (original or copy) b. <input checked="" type="checkbox"/> Copy from a prior application (37 CFR 1.63(d)) (see Box 18)</p> <p>5. <input type="checkbox"/> This application is filed by fewer than all the inventors named in the prior nonprovisional application. a. <input type="checkbox"/> DELETE the following inventor(s) named in the prior nonprovisional application: b. <input type="checkbox"/> The inventor(s) to be deleted are set forth on a separate sheet attached hereto.</p> <p>6. <input checked="" type="checkbox"/> Incorporation by Reference (usable if Box 4b is checked) The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.</p> <p>7. <input type="checkbox"/> Microfiche Computer Program (Appendix)</p> <p>8. <input type="checkbox"/> Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary) a. <input type="checkbox"/> Computer Readable Copy b. <input type="checkbox"/> Paper Copy (identical to computer copy) c. <input type="checkbox"/> Statement verifying identity of above copies</p>	
ACCOMPANYING APPLICATION PARTS	
<p>9. <input type="checkbox"/> Assignment Papers (cover sheet & document(s))</p> <p>10. <input type="checkbox"/> 37 CFR 3.73(b) Statement (when there is an assignee) <input type="checkbox"/> Power of Attorney</p> <p>11. <input type="checkbox"/> English Translation Document (if applicable)</p> <p>12. <input checked="" type="checkbox"/> Foreign priority benefit under 35 U.S.C. §119 is claimed. a. <input checked="" type="checkbox"/> Certified Copy of Priority Document(s) filed in prior application No. <u>09/359,128</u>. b. <input type="checkbox"/> Certified Copy of Priority Document(s) enclosed. c. <input type="checkbox"/> Certified Copy of Priority Document(s) to follow.</p> <p>13. <input checked="" type="checkbox"/> Information Disclosure Statement (IDS)/PTO-1449 <input type="checkbox"/> Copies of IDS Citations</p> <p>14. <input checked="" type="checkbox"/> Preliminary Amendment a. <input checked="" type="checkbox"/> enclosed herewith. b. <input type="checkbox"/> incorporated herein (see Box 18).</p> <p>15. <input checked="" type="checkbox"/> Return Receipt Postcard (MPEP 503) (Should be specifically itemized)</p> <p>16. <input type="checkbox"/> Small Entity Statement(s) <input type="checkbox"/> Statement filed in prior application, status still proper and desired.</p> <p>17. <input type="checkbox"/> Other:</p>	

18. CONTINUING APPLICATION, check appropriate box and supply the requisite information below:

☐ Continuation ☒ Divisional ☐ Continuation-in-part (CIP) of prior application No: 09/359,128

Prior application information: Examiner: Unassigned

Group/Art Unit: 2753

* * *

Preliminary Amendment:

☐ Cancel in this application original claims _____ of the prior application before calculating the filing fee. (At least one original independent claim must be retained for filing purposes.)

☐ Amend the specification by inserting before the first line the sentence:


--This application is a _____ of application number ____ / _____, filed _____, now _____.--

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Jin-gyo SEO, et al.

Group Art Unit: 2753

Serial No: Unassigned

Examiner: Unassigned

Filed: Herewith

For: ADAPTIVE WRITING METHOD FOR HIGH-DENSITY OPTICAL RECORDING
APPARATUS AND CIRCUIT THEREOF

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Before examination on the merits, the following amendments and remarks are
respectfully submitted.

IN THE SPECIFICATION:

Please **AMEND** the specification as follows.

Page 1, before the first line, insert the sentence:

--This application is a divisional of application number 09/359,128, filed July 23, 1999,
now pending.--.

IN THE CLAIMS:

Please **CANCEL** claims 1-18 and 27, without prejudice or disclaimer.

Please **AMEND** claim 19 as follows. The remaining claims are reprinted, as a convenience to the Examiner, as they presently stand before the U.S. Patent and Trademark Office.

1-18 CANCELED.

19. (ONCE AMENDED) An adaptive writing [method] circuit for writing input data on an optical recording medium using a write pulse for a light source and whose waveform comprises a first pulse, a last pulse and a multi-pulse train, the adaptive writing circuit comprising:

a discriminator to discriminate a magnitude of the present mark of the input data and magnitudes of the leading and/or trailing spaces of the present mark;

a generator to control the waveform of the write pulse in accordance with the magnitude of the present mark of the input data and the magnitudes of the leading and/or trailing spaces to generate an adaptive write pulse; and

a driver to drive the light source by converting the adaptive write pulse into a current signal in accordance with driving power levels for respective channels for the adaptive write pulse.

20. (NOT AMENDED) The adaptive writing circuit according to claim 19, wherein the generator includes:

a write waveform controller to generate pulse width data to vary a width of the first pulse in accordance with the magnitude of the leading space and the magnitude of the present mark and to vary a width of the last pulse in accordance with the magnitude of the present mark and the magnitude of the trailing space; and

a write pulse generator to generate the adaptive write pulse in accordance with the pulse width data.

21. (NOT AMENDED) The adaptive writing circuit according to claim 20, wherein the write waveform controller comprises a memory in which the pulse width data of the first and/or last pulses of the write pulse waveform are stored, by grouping the magnitude of the present mark and the magnitudes of the leading and/or trailing spaces, into a short pulse group, a middle pulse group or a long pulse group.

22. (NOT AMENDED) The adaptive writing circuit according to claim 21, further comprising a microcomputer to initialize the write waveform controller and control the pulse width data stored in the memory to be updated in accordance with write conditions.

23. (NOT AMENDED) The adaptive writing circuit according to claim 21, wherein the memory stores the pulse width data of the first and/or last pulses of a write pulse waveform depending on whether the input data is in a land track or a groove track.

24. (NOT AMENDED) The adaptive writing circuit according to claim 21, wherein the memory stores the pulse width data of the first and/or last pulses of the write pulse waveform for respective zones on the optical recording medium.

25. (NOT AMENDED) The adaptive writing circuit according to claim 20, wherein light power for a predetermined one of channels of the adaptive write pulse is applied during a period corresponding to a varied width of the first pulse and during a period corresponding to a varied width of the last pulse.

26. (NOT AMENDED) The adaptive writing circuit according to claim 25, wherein the light power for the predetermined channel is a read power or a write power.

27. CANCELED.

Please **ADD** new claims 28-33 as follows.

28. (NEW) The adaptive writing circuit according to claim 19, wherein the generator generates pulse width data by varying a rising edge of the first pulse in accordance with the magnitude of the leading space and the magnitude of the present mark.

29. (NEW) The adaptive writing circuit according to claim 19, wherein the generator generates pulse width data by varying a falling edge of the first pulse in accordance with the magnitude of the leading space and the magnitude of the present mark.

30. (NEW) The adaptive writing circuit according to claim 19, wherein the generator generates pulse width data by varying a rising edge of the last pulse in accordance with the magnitude of the trailing space and the magnitude of the present mark.

31. (NEW) The adaptive writing circuit according to claim 19, wherein the generator generates pulse width data by varying a falling edge of the last pulse in accordance with the magnitude of the trailing space and the magnitude of the present mark.

32. (NEW) An adaptive writing circuit for writing input data to a optical recording medium using a write pulse for a light source and whose waveform includes a first pulse, a last pulse and a multi-pulse train, comprising:

a generator to generate an adaptive write pulse by varying a falling edge of the first pulse in accordance with a magnitude of a leading space and a magnitude of the present mark, and varying a falling edge of the second pulse in accordance with the magnitude of a trailing space and the magnitude of the present mark; and

a driver to drive the light source according to the adaptive write pulse.

33. (NEW) An adaptive write pulse generating circuit, the adaptive write pulse being used for writing input data to an optical recording medium, comprising:

a write pulse inputting unit inputting a write pulse, the write pulse including a first pulse, a last pulse and a multi-pulse train;

a generator generating the adaptive write pulse by varying a falling edge of the first pulse in accordance with a magnitude of a leading space and a magnitude of a present mark, and varying a falling edge of the second pulse in accordance with a magnitude of a trailing space and the magnitude of the present mark; and

an outputting unit to output the generated adaptive write pulse.

REMARKS

INTRODUCTION:

In accordance with the foregoing, claims 1-18 and 27 have been canceled without prejudice or disclaimer, claim 19 has been amended, and claims 28-33 have been added. No new matter is being presented, and approval and entry are respectfully requested.

Claims 19-26 and 28-33 are pending and under consideration.

CONCLUSION:

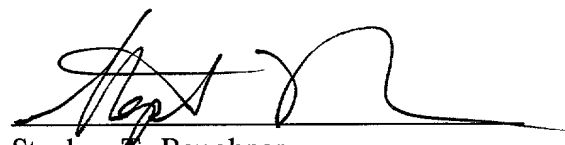
If the Examiner has any remaining informalities to be addressed, it is believed that prosecution can be expedited by the Examiner contacting the undersigned attorney for a telephone interview to discuss resolution of such informalities.

If there are any additional fees associated with filing of this Preliminary Amendment, please charge the same to our Deposit Account No. 19-3935.

Respectfully submitted,
STAAS & HALSEY LLP

Date: July 3, 2000

By:


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TITLE OF THE INVENTION

**ADAPTIVE WRITING METHOD
FOR HIGH-DENSITY OPTICAL RECORDING APPARATUS
AND CIRCUIT THEREOF**

5 CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of Korean Application No. 98-29732, filed July 23, 1998, in the Korean Patent Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

10 1. Field of the Invention

The present invention relates to an adaptive writing method for a high-density optical recording apparatus and a circuit thereof, and more particularly, to an adaptive writing method for optimizing light power of a light source, e.g., a laser diode, to be suitable to characteristics of a recording apparatus, and a circuit thereof.

15 2. Description of the Related Art

With the multi-media era requiring high-capacity recording media, optical recording systems employing high-capacity recording media, such as a magnetic optical disc drive (MODD) or a digital versatile disc random access memory (DVD-RAM) drive, have been widely used.

20 As the recording density increases, such optical recording systems require optimal and high-precision states. In general, with an increase in recording density, temporal fluctuation (to be referred to as jitter, hereinafter) in a data domain increases. Thus, in order to attain efficient high-density recording, it is very important to minimize the jitter.

25 Conventionally, a write pulse is formed as specified in the DVD-RAM specifications shown in FIG. 1B, with respect to input NRZI (Non-Return to Zero Inversion) data having marks of 3T, 5T and 11T (T being the channel clock duration),

as shown in FIG. 1A. Here, the NRZI data is divided into marks and spaces. The spaces are in an erase power level for overwriting. The waveform of a write pulse for marks equal to or longer than 3T mark, that is, 3T, 4T,...11T and 14T is comprised of a first pulse, a last pulse and a multi-pulse train. Here, only the number of pulses in the multi-pulse train is varied depending on the magnitude of a mark.

In other words, the waveform of the write pulse is comprised of a combination of read power (FIG. 1C), peak power or write power (FIG. 1D) and bias power or erase power (FIG. 1E). Here, the respective power signals shown in FIGS. 1C, 1D and 1E are all low-active signals.

The waveform of the write pulse is the same as that in accordance with the first generation 2.6 GB DVD-RAM standard. In other words, in accordance with the 2.6 GB DVD-RAM standard, the waveform of the write pulse is comprised of a first pulse, a multi-pulse train and a last pulse. Although the rising edge of the first pulse or the falling edge of the last pulse can be read from a lead-in area to be used, adaptive writing is not possible since the write pulse is fixed to be constant.

Therefore, when a write operation is performed by forming such a write pulse as shown in FIG. 1B, severe thermal interference may occur back and forth with respect to a mark in accordance with input NRZI data. In other words, when a mark is long and a space is short or vice versa, jitter is most severe. This is a major cause of lowered system performance. Also, this does not make it possible for the system to be applied to high-density DVD-RAMs, e.g., second generation 4.7 GB DVD-RAMs.

SUMMARY OF THE INVENTION

To solve the above problems, it is an object of the present invention to provide an adaptive writing method of a write pulse generated in accordance with the magnitude of the present mark of input data and the magnitudes of the leading and/or trailing spaces thereof.

It is another object of the present invention to provide an adaptive writing circuit for a high-density optical recording apparatus for optimizing light power of a laser diode by generating an adaptive write pulse in accordance with the magnitude

of the present mark of input data and the magnitudes of the leading and trailing spaces thereof.

Additional objects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may
5 be learned by practice of the invention.

Accordingly, to achieve the first and other objects of the present invention, there is provided a method of writing input data on an optical recording medium using a write pulse whose waveform is comprised of a first pulse, a last pulse and a multi-pulse train, the adaptive writing method including the steps of controlling the
10 waveform of the write pulse in accordance with the magnitude of the present mark of the input data and the magnitudes of the leading and/or trailing spaces to generate an adaptive write pulse, and writing the input data by the adaptive write pulse on the optical recording medium.

To achieve the second and other objects of the present invention, there is
15 provided an apparatus for writing input data on an optical recording medium using a write pulse for a light source and whose waveform is comprised of a first pulse, a last pulse and a multi-pulse train, the adaptive writing circuit including a discriminator for discriminating the magnitude of the present mark of the input data and the magnitudes of the leading and/or trailing spaces, a generator for controlling the
20 waveform of the write pulse in accordance with the magnitude of the present mark of the input data and the magnitudes of the leading and/or trailing spaces to generate an adaptive write pulse, and a driver for driving the light source by converting the adaptive write pulse into a current signal in accordance with driving power levels for the respective channels.

25 BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects and advantages of the present invention will become more apparent by describing in detail a preferred embodiment thereof with reference to the attached drawings, in which:

FIGS. 1A through 1E are waveform diagrams of conventional write pulses;

FIG. 2 is a block diagram of an adaptive writing circuit for a high-density optical recording apparatus according to an embodiment of the present invention;

FIGS. 3A through 3G are waveform diagrams of an adaptive write pulse recorded by the adaptive writing circuit shown in FIG. 2;

5 FIG. 4 illustrates grouping of input data according to the embodiment of the present invention;

FIG. 5 is a table illustrating the combination of pulses generated by the grouping shown in FIG. 4;

10 FIG. 6 is a table illustrating rising edge shift values of a first pulse according to the embodiment of the present invention;

FIG. 7 is a table illustrating falling edge shift values of a last pulse according to the embodiment of the present invention;

FIG. 8 is a flowchart of an adaptive writing method according to the embodiment of the present invention; and

15 FIG. 9 is a graph for comparing jitter generated by the adaptive writing method of the present invention and the conventional writing method.

DESCRIPTION OF THE PREFERRED EMBODIMENT

20 Hereinafter, a preferred embodiment of an adaptive writing method for a high-density optical recording apparatus and a circuit thereof will be described with reference to the accompanying drawings.

25 An adaptive writing circuit according to an embodiment of the present invention, as shown in FIG. 2, includes a data discriminator 102, a write waveform controller 104, a microcomputer 106, a write pulse generator 108 and a current driver 110. In other words, the data discriminator 102 discriminates input NRZI data. The write waveform controller 104 corrects the waveform of a write pulse in accordance with the discrimination result of the data discriminator 102 and a land/groove signal. The microcomputer 106 initializes the write waveform controller 104 or controls the data stored in the write waveform controller 104 to be updated in accordance with write conditions. The write pulse generator 108 generates an adaptive write pulse in
30 accordance with the output of the write waveform controller 104. The current driver

110 converts the adaptive write pulse generated from the write pulse generator 108 into a current signal in accordance with the light power levels of the respective channels to drive a light source.

Next, the operation of the apparatus shown in FIG. 2 will be described with reference to FIGS. 3 through 7.

In FIG. 2, the data discriminator 102 discriminates the magnitude of a mark corresponding to the present write pulse (to be referred to as a present mark), the magnitude of the front-part space corresponding to the first pulse of the present mark (to be referred to as a leading space, hereinafter) and the magnitude of the rear-part space corresponding to the last pulse of the present mark (to be referred to as a trailing space) from input NRZI data, and applies the magnitudes of the leading and trailing spaces and the magnitude of the present mark to the write waveform controller 104.

Here, the magnitudes of the leading and trailing spaces and the magnitude of the present mark may range from $3T$ to $14T$. There can be more than 1,000 possible combinations. Thus, circuits or memories for obtaining the amounts of shift in rising edges of the first pulses and falling edges of the last pulses are necessary with respect to all cases, which complicates the system and hardware. Therefore, in the present invention, the magnitudes of the present mark and the leading and trailing spaces of input NRZI data are grouped into a short pulse group, a middle pulse group and a long pulse group and the grouped magnitudes of the present mark and the leading and trailing spaces are used.

The write waveform controller 104 shifts the rising edge of the first pulse back and forth in accordance with the magnitudes of the leading space and the present mark, supplied from the data discriminator 102, or shifts the falling edge of the last pulse back and forth in accordance with the magnitudes of the present mark and the trailing space, to thus form a write waveform having an optimal light power. Here, the multi-pulse train of a mark takes the same shape as shown in FIG. 3B, that is, $0.5 T$.

Also, the write waveform controller 104 can correct the rising edge of the first pulse of the present mark and the falling edge of the last pulse of the present mark into different values in accordance with externally applied land/groove signals

(LAND/GROOVE) indicating whether the input NRZI data is in a land track or a groove track. This is for forming a write waveform in consideration of different optimal light powers depending on the land and groove. There is a difference of 1-2 mW in the optimal light powers between the land and the groove, and this difference may be specifically set or managed by the specifications.

Therefore, the write waveform controller 104 may be constituted by a memory in which data corresponding to a shift value of the rising edge of the first pulse and a shift value of the falling edge of the last pulse in accordance with the magnitude of the present mark of input NRZI data and the magnitudes of the leading and trailing spaces thereof, is stored, or a logic circuit. In the case that the write waveform controller 104 is constituted by a memory, the widths of the first pulse and the last pulse are determined as channel clocks (T) plus and minus a data value (shift value) stored in the memory. Also, in this memory, shift values of the first and last pulses of the mark for each of a land and a groove may be stored. A single table in which the shift value of the rising edge of the first pulse is stored and in which the shift value of the falling edge of the last pulse is stored may be incorporated. Alternatively, as shown in FIGS. 6 and 7, two separate tables may be prepared.

The microcomputer 106 initializes the write waveform controller 104 or controls the shift values of the first and/or last pulse(s) to be updated in accordance with recording conditions. In particular, in accordance with zones, the light power can vary or the shift values of the first and last pulses can be reset.

The pulse width data for controlling the waveform of the write pulse is provided to the write pulse generator 108. The write pulse generator 108 generates an adaptive write pulse, as shown in FIG. 3F, in accordance with the pulse width data for controlling the waveform of the write pulse supplied from the write waveform controller 104 and supplies control signals shown in FIGS. 3C, 3D and 3E, for controlling the current flow for the respective channels (i.e., read, peak and bias channels) for the adaptive write pulse, to the current driver 110.

The current driver 110 converts the driving level of the light power of the respective channels (i.e., read, peak and bias channels) into current for a control time corresponding to the control signal for controlling the current flow of the respective

channels to allow the current to flow through the laser diode so that an appropriate amount of heat is applied to the recording medium by continuous ON-OFF operations of the laser diode or a change in the amounts of light. Here, a record domain as shown in FIG. 3G is formed on the recording medium.

5 FIG. 3A shows input NRZI data, which is divided into marks and spaces. FIG. 3B shows a basic write waveform, in which the rising edge of the first pulse of the write pulse lags behind by $0.5T$, compared to the rising edge of the present mark. FIG. 3C shows the waveform of a read power of the adaptive write pulse, FIG. 3D shows the waveform of a peak power of the adaptive write pulse, and FIG. 3E shows
10 the waveform of a bias power of the adaptive write pulse. FIG. 3F shows the waveform of the adaptive write pulse according to the embodiment of the present invention. The rising edge of the first pulse of the write waveform of the adaptive write pulse may be shifted back and forth in accordance with a combination of the magnitude of the leading space and the magnitude of the present mark. An arbitrary
15 power (here, a read power or a write power) is applied during the period corresponding to the shift. Likewise, the falling edge of the last pulse of the adaptive write pulse may be shifted back and forth in accordance with a combination of the magnitude of the present mark and the magnitude of the trailing space. Also, an
20 arbitrary power (here, a read power or a write power) is applied during the period corresponding to the shift.

 Alternatively, the falling edge of the last pulse may be shifted back and forth in accordance with the magnitude of the present mark, regardless of the magnitude of the trailing space of the present mark. Also, rather than shifting the rising edge of the first pulse and the falling edge of the last pulse, the edge of any one pulse may be
25 shifted. Also, in view of the direction of shift, shifting may be performed back and forth, only forward or only backward.

 FIG. 4 illustrates grouping of input NRZI data, showing two examples of grouping. In the first example, if a low grouping pointer is 3 and a high grouping pointer is 12, then the mark of a short pulse group is $3T$, the marks of a middle pulse group are from $4T$ to $11T$ and the mark of a long pulse group is $14T$. In the second
30 example, if a low grouping pointer is 4 and a high grouping pointer is 11, then the

marks of a short pulse group are 3T and 4T, the marks of a middle pulse group are from 5T to 10T and the marks of a long pulse group are 11T and 14T. As described above, since both the low grouping pointer and the high grouping pointer are used, utility efficiency is enhanced. Also, grouping can be performed differently for the respective zones.

FIG. 5 illustrates the number of cases depending on combinations of leading and trailing spaces and present marks, in the case of classifying input NRZI data into three groups, as shown in FIG. 4, using grouping pointers. FIG. 6 illustrates a table showing shift values of rising edges of the first pulse depending on the magnitude of the leading space and the magnitude of the present mark. FIG. 7 illustrates a table showing shift values of falling edges of the last pulse depending on the magnitude of the present mark and the magnitude of the trailing space.

FIG. 8 is a flow chart illustrating an adaptive writing method according to the embodiment of the present invention. First, a write mode is set (step S101). If the write mode is set, it is determined whether it is an adaptive write mode or not (step S102). If it is determined in step S102 that the write mode is an adaptive write mode, grouping pointers are set (step S103). Then, a grouping table depending on the set grouping pointers is selected (step S104). The selected grouping table may be a table reflecting land/groove as well as the grouping pointer. Also, the selected grouping table may be a table reflecting zones of the recording medium.

A shift value of the rising edge of the first pulse is read from the table shown in FIG. 6 in accordance with a combination (of magnitudes) of the leading space and present mark (S105).

A shift value of the falling edge of the last pulse is read from the table shown in FIG. 7 in accordance with a combination (of magnitudes) of the present mark and the trailing space (step S106).

The adaptive write pulse in which the first pulse and the last pulse are controlled in accordance with the read shift values is generated (step S107). Then, the light powers of the respective channels for the generated adaptive write pulse, i.e., read, peak and bias powers, are controlled to drive a laser diode (step S108) to

then perform a write operation on a disc (step S109). If the write mode is not an adaptive write mode, a general write pulse is generated in step S107.

FIG. 9 is a graph for comparing jitter generated by the adaptive writing method according to the embodiment of the present invention and the conventional writing method. It is understood that, assuming that the peak light is 9.5 mW, the bottom power of a multi-pulse train is 1.2 mW, the cooling power is 1.2 mW and the bias power is 5.2 mW, there is less jitter generated when writing the adaptive write pulse according to the present invention than when generated writing the fixed write pulse according to the conventional writing method. The initialization conditions are a speed of 4.2 m/s, an erase power of 7.2 mW and 100 write operations.

In other words, according to the present invention, in adaptively varying the marks of a write pulse, the rising edge of the first pulse is adaptively shifted in accordance with the magnitude of the leading space and the magnitude of the present mark of input NRZI data to thus control the waveform of the write pulse, and/or the falling edge of the last pulse is adaptively shifted in accordance with the magnitude of the present mark and the magnitude of the trailing space of the input NRZI data to thus control the waveform of the write pulse, thereby minimizing jitter. Also, the waveform of the write pulse may be optimized in accordance with land/groove signals. Also, in the present invention, grouping may be performed differently for the respective zones, using grouping pointers.

A new adaptive writing method according to the present invention can be adopted to most high-density optical recording apparatuses using an adaptive writing pulse.

As described above, the widths of the first and/or last pulses of a write pulse waveform are varied in accordance with the magnitude of the present mark of input NRZI data and the magnitude of the leading or trailing space, thereby minimizing jitter to enhance system reliability and performance. Also, the width of a write pulse is controlled by grouping the magnitude of the present mark and the magnitude of the leading or trailing spaces, thereby reducing the size of hardware.

Although a preferred embodiment of the present invention has been shown and described, it would be appreciated by those skilled in the art that changes may

[illegible]

What is claimed is:

What is claimed is:

1. An adaptive writing method of writing input data on an optical recording medium using a write pulse whose waveform comprises a first pulse, a last pulse and a multi-pulse train, the adaptive writing method comprising:

(a) controlling the waveform of the write pulse in accordance with a magnitude of a present mark of the input data and magnitudes of a leading and/or trailing spaces of the present mark to generate an adaptive write pulse; and

(b) writing the input data on the optical recording medium using the adaptive write pulse.

2. The adaptive writing method according to claim 1, wherein the step (a) includes generating the adaptive write pulse by varying a rising edge of the first pulse in accordance with the magnitude of the leading space and the magnitude of the present mark.

3. The adaptive writing method according to claim 1, wherein the step (a) includes generating the adaptive write pulse by varying a falling edge of the last pulse in accordance with the magnitude of the present mark and the magnitude of the trailing space.

4. The adaptive writing method according to claim 1, wherein the step (a) includes generating the adaptive write pulse by varying a rising edge of the first pulse in accordance with the magnitude of the leading space and the magnitude of the present mark, and varying a falling edge of the last pulse in accordance with the magnitude of the present mark and the magnitude of the trailing space.

5. The adaptive writing method according to claim 1, wherein the step (a) includes generating the adaptive write pulse by shifting a rising edge of the first pulse in accordance with the magnitude of the leading space and the magnitude of the

present mark, and shifting the falling edge of the last pulse in accordance with the magnitude of the present mark and the magnitude of the trailing space.

6. The adaptive writing method according to claim 5, further comprising applying a light power for a predetermined channel during a period corresponding to the shift of the rising edge of the first pulse and during a period corresponding to the shift of the falling edge of the last pulse.

7. The adaptive writing method according to claim 6, wherein the light power for the predetermined channel is read power or write power.

8. The adaptive writing method according to claim 1, further comprising correcting the waveform of the adaptive write pulse in accordance with a land/groove signal indicating whether the input data is data of a land track or data of a groove track.

9. An adaptive writing method comprising:
(a) selecting one of grouping tables grouped by the magnitudes of marks and spaces of input data, using grouping pointers;
(b) calculating a width of a write pulse using data stored in the selected grouping table; and
(c) writing the input data using an adaptive write pulse generated in response to the calculated width on an optical recording medium.

10. The adaptive writing method according to claim 9, wherein the grouping tables store width data of first and/or last pulses of the write pulse waveform, by grouping a magnitude of a present mark of the input data and magnitudes of leading and/or trailing spaces of the present mark, into a short pulse group, a middle pulse group or a long pulse group.

1 11. The adaptive writing method according to claim 9, wherein the grouping
2 tables store width data of the first and/or last pulses of the write pulse waveform, by
3 grouping a magnitude of a present mark of the input data and magnitudes of the
4 leading and/or trailing spaces of the present mark, into a short pulse group, a middle
5 pulse group or a long pulse group, depending on whether the input data is in a land
6 track or a groove track.

1 12. The adaptive writing method according to claim 9, wherein the grouping
2 tables store width data of the first and/or last pulses of the write pulse waveform, by
3 grouping a magnitude of a present mark of the input data and magnitudes of the
4 leading and/or trailing spaces of the present mark, into a short pulse group, a middle
5 pulse group or a long pulse group, for respective zones on the optical recording
6 medium.

1 13. The adaptive writing method according to claim 9, wherein the step (b)
2 comprises:

3 (b1) reading a shift value of a rising edge of a first pulse of the write pulse in
4 accordance with a combination of a magnitude of a leading space and a magnitude of
5 the present mark to calculate width data of the first pulse; and

6 (b2) reading a shift value of a falling edge of a last pulse of the write pulse in
7 accordance with a combination of the magnitude of the present mark and a
8 magnitude of a trailing space to calculate width data of the last pulse.

1 14. An adaptive writing method of writing input data on an optical recording
2 medium using a write pulse whose waveform comprises a first pulse, a last pulse and
3 a multi-pulse train, to optimize a light power of a light source, the adaptive writing
4 method comprising:

5 (a) discriminating between magnitudes of a present mark of the input data and
6 leading and/or trailing spaces of the present mark;

7 (b) generating pulse width data for varying widths of the first and/or last pulses
8 of the write pulse waveform in accordance with the magnitude of the present mark
9 and the magnitudes of the leading and/or trailing spaces; and

10 (c) generating an adaptive write pulse in accordance with the pulse width data,
11 and converting the adaptive write pulse into a current signal in accordance with
12 driving power levels for respective channels for the adaptive write pulse to drive the
13 light source.

1 15. The adaptive writing method according to claim 14, wherein the step (b)
2 comprises:

3 (b1) generating first pulse width data for shifting a rising edge of the first pulse
4 in accordance with the magnitude of the leading space and the magnitude of the
5 present mark; and

6 (b2) generating last pulse width data for shifting a falling edge of the last pulse
7 in accordance with the magnitude of the present mark and the magnitude of the
8 trailing space.

1 16. The adaptive writing method according to claim 15, further comprising
2 applying the light power for a predetermined one of the channels during a period
3 corresponding to the shift of the rising edge of the first pulse and during a period
4 corresponding to the shift of the falling edge of the last pulse.

1 17. The adaptive writing method according to claim 16, wherein the light
2 power for the predetermined channel is read power or write power.

1 18. The adaptive writing method according to claim 14, further comprising:
2 (d) correcting a waveform of the adaptive write pulse in accordance with a
3 land/groove signal indicating whether the input data is data of a land track or data of
4 a groove track, wherein the input data is NRZI (Non-Return Zero Inversion) data.

1 19. An adaptive writing method circuit for writing input data on an optical
2 recording medium using a write pulse for a light source and whose waveform
3 comprises a first pulse, a last pulse and a multi-pulse train, the adaptive writing circuit
4 comprising:

5 a discriminator to discriminate a magnitude of the present mark of the input
6 data and magnitudes of the leading and/or trailing spaces of the present mark;

7 a generator to control the waveform of the write pulse in accordance with the
8 magnitude of the present mark of the input data and the magnitudes of the leading
9 and/or trailing spaces to generate an adaptive write pulse; and

10 a driver to drive the light source by converting the adaptive write pulse into a
11 current signal in accordance with driving power levels for respective channels for the
12 adaptive write pulse.

1 20. The adaptive writing circuit according to claim 19, wherein the generator
2 includes:

3 a write waveform controller to generate pulse width data to vary a width of the
4 first pulse in accordance with the magnitude of the leading space and the magnitude
5 of the present mark and to vary a width of the last pulse in accordance with the
6 magnitude of the present mark and the magnitude of the trailing space; and

7 a write pulse generator to generate the adaptive write pulse in accordance with
8 the pulse width data.

1 21. The adaptive writing circuit according to claim 20, wherein the write
2 waveform controller comprises a memory in which the pulse width data of the first
3 and/or last pulses of the write pulse waveform are stored, by grouping the magnitude
4 of the present mark and the magnitudes of the leading and/or trailing spaces, into a
5 short pulse group, a middle pulse group or a long pulse group.

1 22. The adaptive writing circuit according to claim 21, further comprising a
2 microcomputer to initialize the write waveform controller and control the pulse width
3 data stored in the memory to be updated in accordance with write conditions.

1 23. The adaptive writing circuit according to claim 21, wherein the memory
2 stores the pulse width data of the first and/or last pulses of a write pulse waveform
3 depending on whether the input data is in a land track or a groove track.

1 24. The adaptive writing circuit according to claim 21, wherein the memory
2 stores the pulse width data of the first and/or last pulses of the write pulse waveform
3 for respective zones on the optical recording medium.

1 25. The adaptive writing circuit according to claim 20, wherein light power
2 for a predetermined one of channels of the adaptive write pulse is applied during a
3 period corresponding to a varied width of the first pulse and during a period
4 corresponding to a varied width of the last pulse.

1 26. The adaptive writing circuit according to claim 25, wherein the light
2 power for the predetermined channel is a read power or a write power.

1 27. The adaptive writing method according to claim 1, wherein the step (a)
2 comprises:
3 grouping each of a magnitude of the present mark and the magnitudes of the
4 leading and/or trailing spaces into groups;
5 comparing the group of the magnitude of the present mark with the groups of
6 the leading and/or trailing spaces; and
7 shifting a rising edge of the first pulse and/or a falling edge of the last pulse
8 based upon the comparisons of the group of the magnitude of the present mark with
9 the groups of the leading and/or trailing spaces, respectively.

ABSTRACT OF THE DISCLOSURE

An adaptive writing method of a high-density optical recording apparatus and a circuit thereof. The circuit includes a discriminator for discriminating a magnitude of a present mark of input NRZI data and magnitudes of leading and/or trailing spaces of the input NRZI data, a generator for controlling the waveform of a write pulse in accordance with the magnitude of the present mark of the input NRZI data and the magnitudes of the leading and/or trailing spaces of the input NRZI data to generate an adaptive write pulse, and a driver for driving a light source by converting the adaptive write pulse into a current signal in accordance with driving power levels for respective channels of the adaptive write pulse. The widths of the first and/or last pulses of the write pulse waveform are varied in accordance with the magnitude of the present mark of input NRZI data and the magnitude of the leading and/or trailing spaces, thereby minimizing jitter to enhance system reliability and performance.

(PRIOR ART)

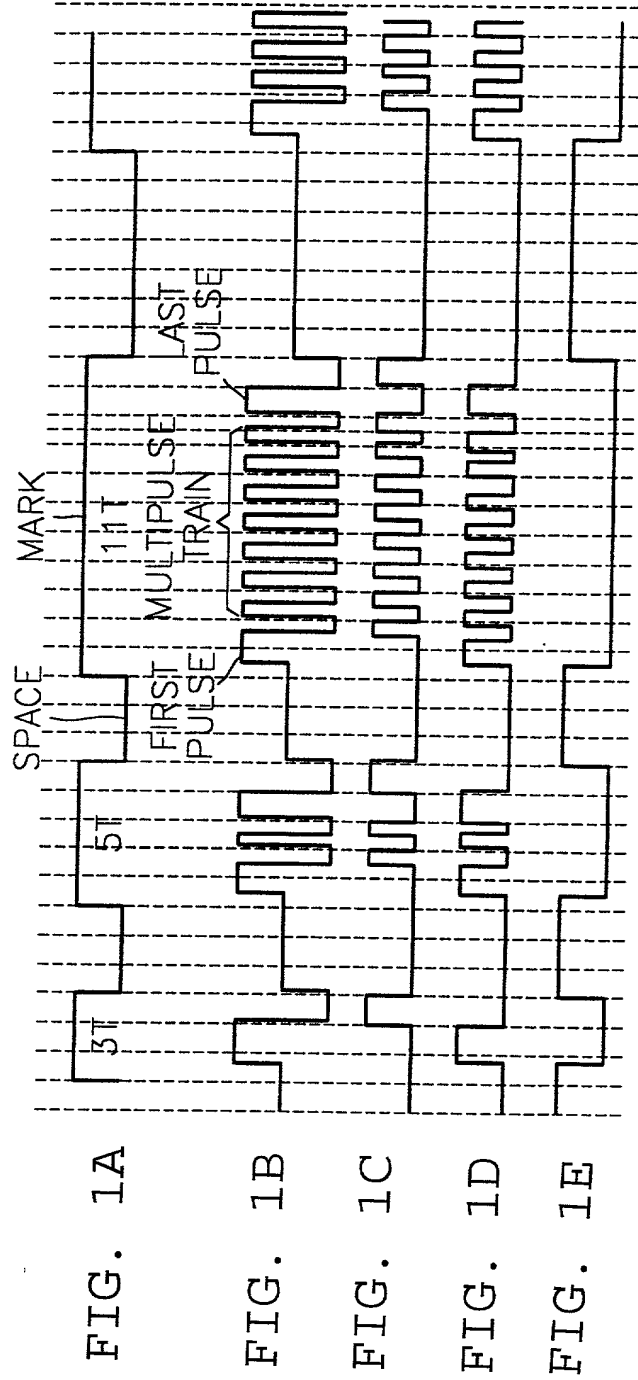


FIG. 2

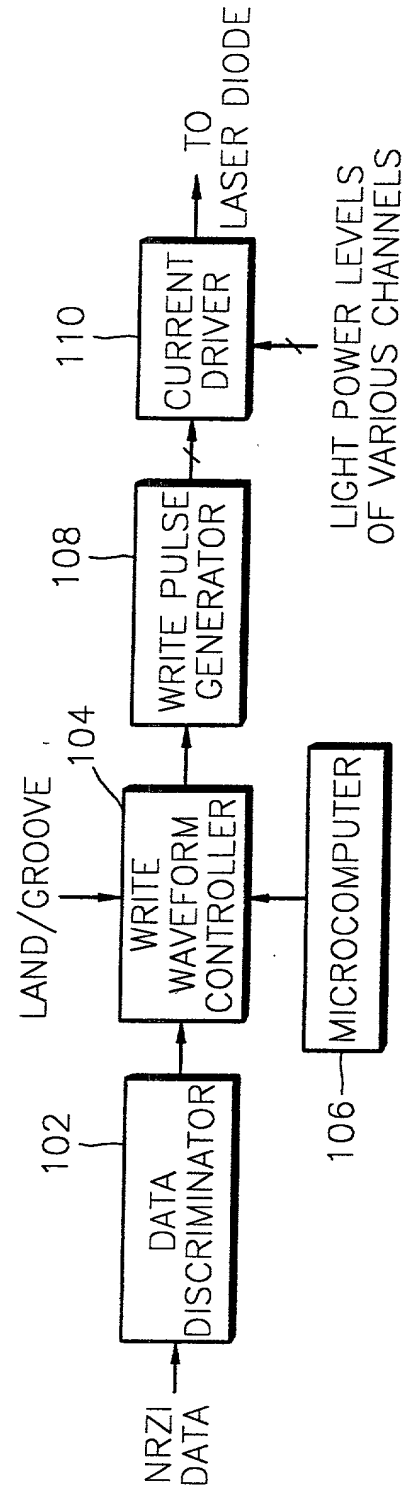


FIG. 3

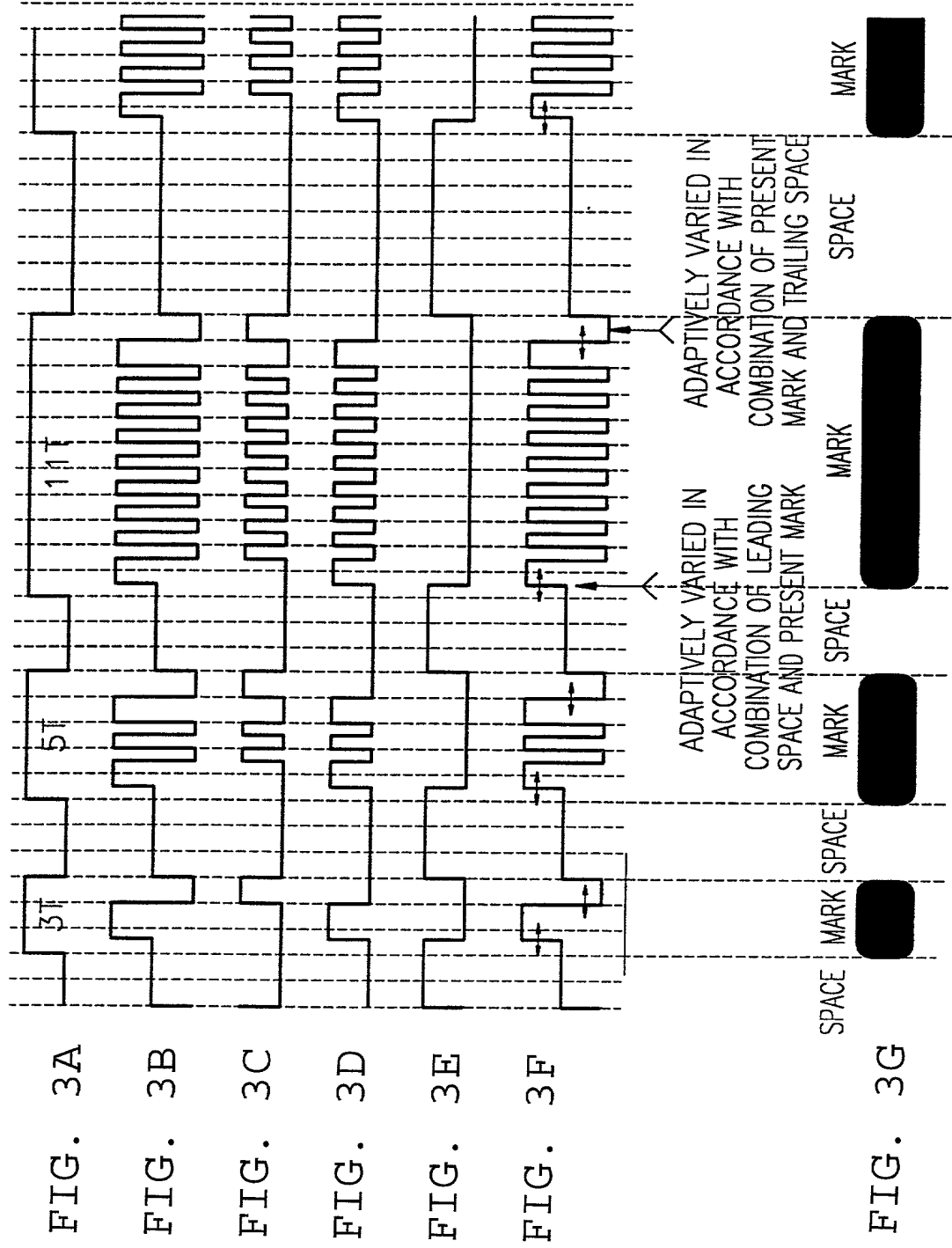


FIG. 4

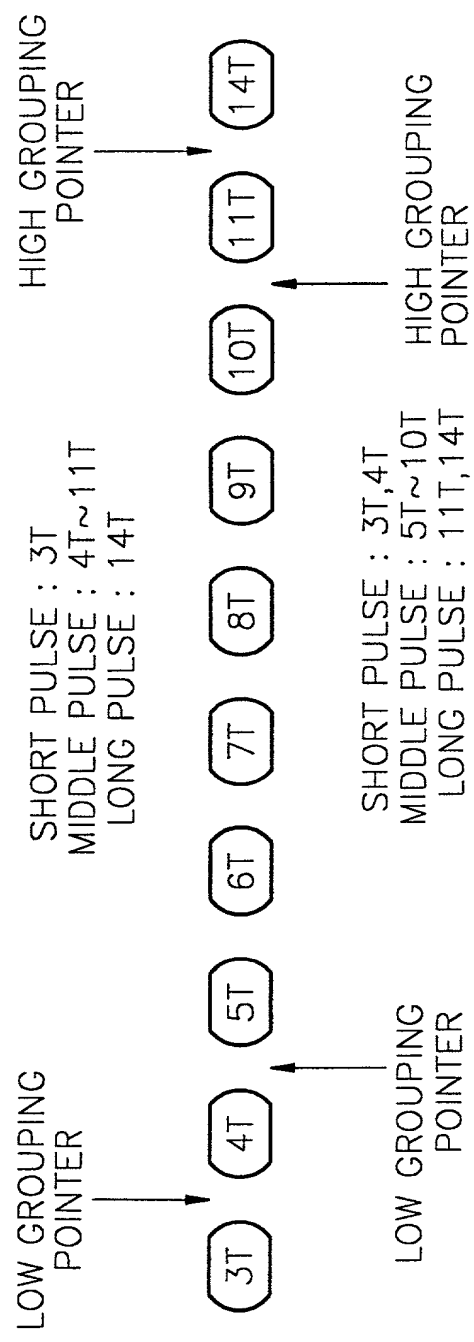


FIG. 5

LEADING SPACE	PRESENT MARK	TRAILING SPACE
SHORT PULSE	SHORT PULSE	SHORT PULSE
SHORT PULSE	SHORT PULSE	MIDDLE PULSE
SHORT PULSE	SHORT PULSE	LONG PULSE
SHORT PULSE	MIDDLE PULSE	SHORT PULSE
SHORT PULSE	MIDDLE PULSE	MIDDLE PULSE
SHORT PULSE	MIDDLE PULSE	LONG PULSE
SHORT PULSE	LONG PULSE	SHORT PULSE
SHORT PULSE	LONG PULSE	MIDDLE PULSE
SHORT PULSE	LONG PULSE	LONG PULSE
MIDDLE PULSE	SHORT PULSE	SHORT PULSE
MIDDLE PULSE	SHORT PULSE	MIDDLE PULSE
MIDDLE PULSE	SHORT PULSE	LONG PULSE
MIDDLE PULSE	MIDDLE PULSE	SHORT PULSE
MIDDLE PULSE	MIDDLE PULSE	MIDDLE PULSE
MIDDLE PULSE	MIDDLE PULSE	LONG PULSE
MIDDLE PULSE	LONG PULSE	SHORT PULSE
MIDDLE PULSE	LONG PULSE	MIDDLE PULSE
MIDDLE PULSE	LONG PULSE	LONG PULSE
LONG PULSE	SHORT PULSE	SHORT PULSE
LONG PULSE	SHORT PULSE	MIDDLE PULSE
LONG PULSE	SHORT PULSE	LONG PULSE
LONG PULSE	MIDDLE PULSE	SHORT PULSE
LONG PULSE	MIDDLE PULSE	MIDDLE PULSE
LONG PULSE	MIDDLE PULSE	LONG PULSE
LONG PULSE	LONG PULSE	SHORT PULSE
LONG PULSE	LONG PULSE	MIDDLE PULSE
LONG PULSE	LONG PULSE	LONG PULSE

FIG. 6

LEADING SPACE	PRESENT MARK	RIISING EDGE SHIFT OF FIRST PULSE(ns)
SHORT PULSE	SHORT PULSE	+1
SHORT PULSE	MIDDLE PULSE	-1
SHORT PULSE	LONG PULSE	-3
MIDDLE PULSE	SHORT PULSE	+2
MIDDLE PULSE	MIDDLE PULSE	0
MIDDLE PULSE	LONG PULSE	-2
LONG PULSE	SHORT PULSE	-3
LONG PULSE	MIDDLE PULSE	-1
LONG PULSE	LONG PULSE	0

FIG. 7

PRESENT MARK	SPACE MARK	FALLING EDGE SHIFT OF LAST PULSE(ns)
SHORT PULSE	SHORT PULSE	+1
MIDDLE PULSE	SHORT PULSE	+2
LONG PULSE	SHORT PULSE	+4
SHORT PULSE	MIDDLE PULSE	-1
MIDDLE PULSE	MIDDLE PULSE	0
LONG PULSE	MIDDLE PULSE	+1
SHORT PULSE	LONG PULSE	-3
MIDDLE PULSE	LONG PULSE	-1
LONG PULSE	LONG PULSE	0

FIG. 8

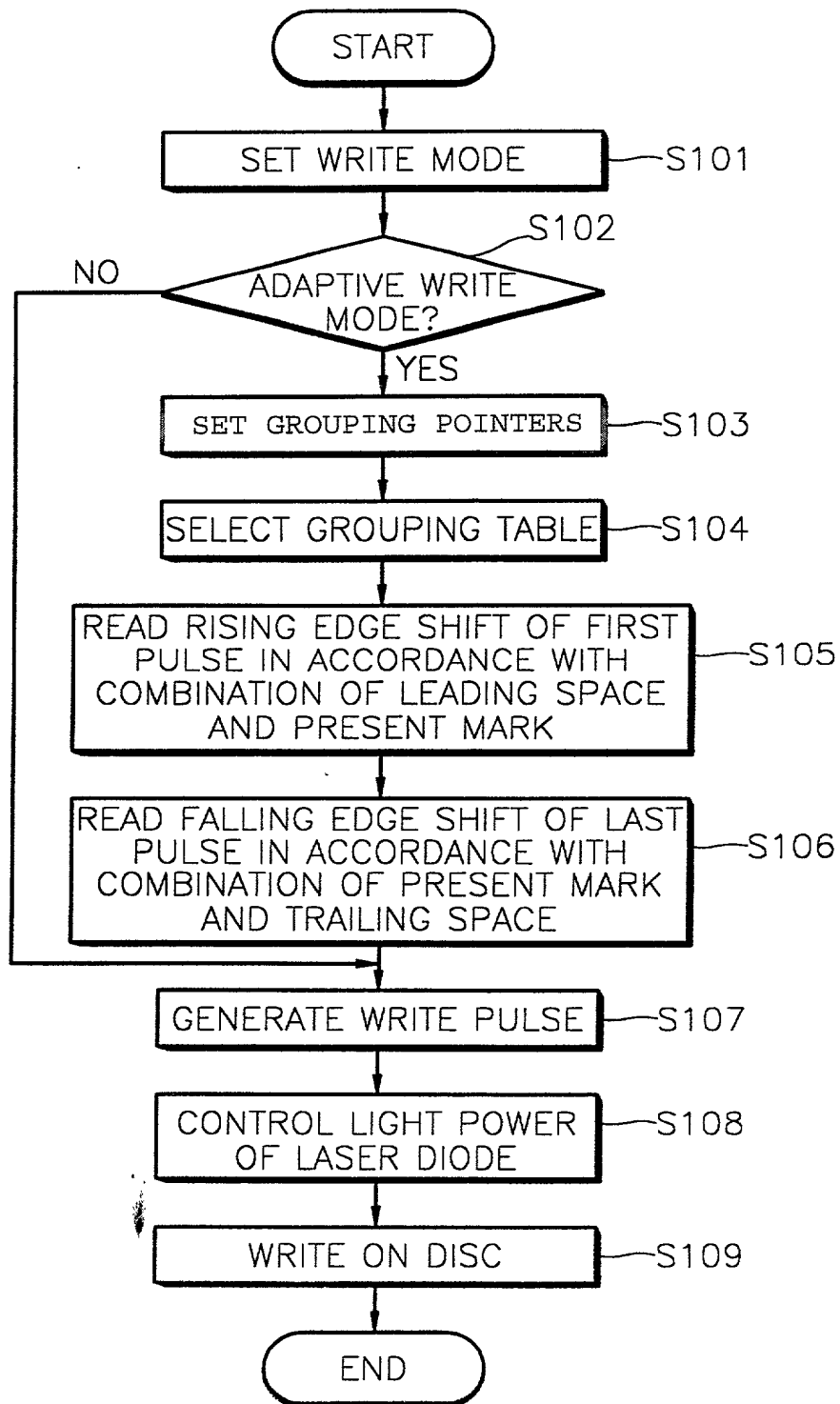
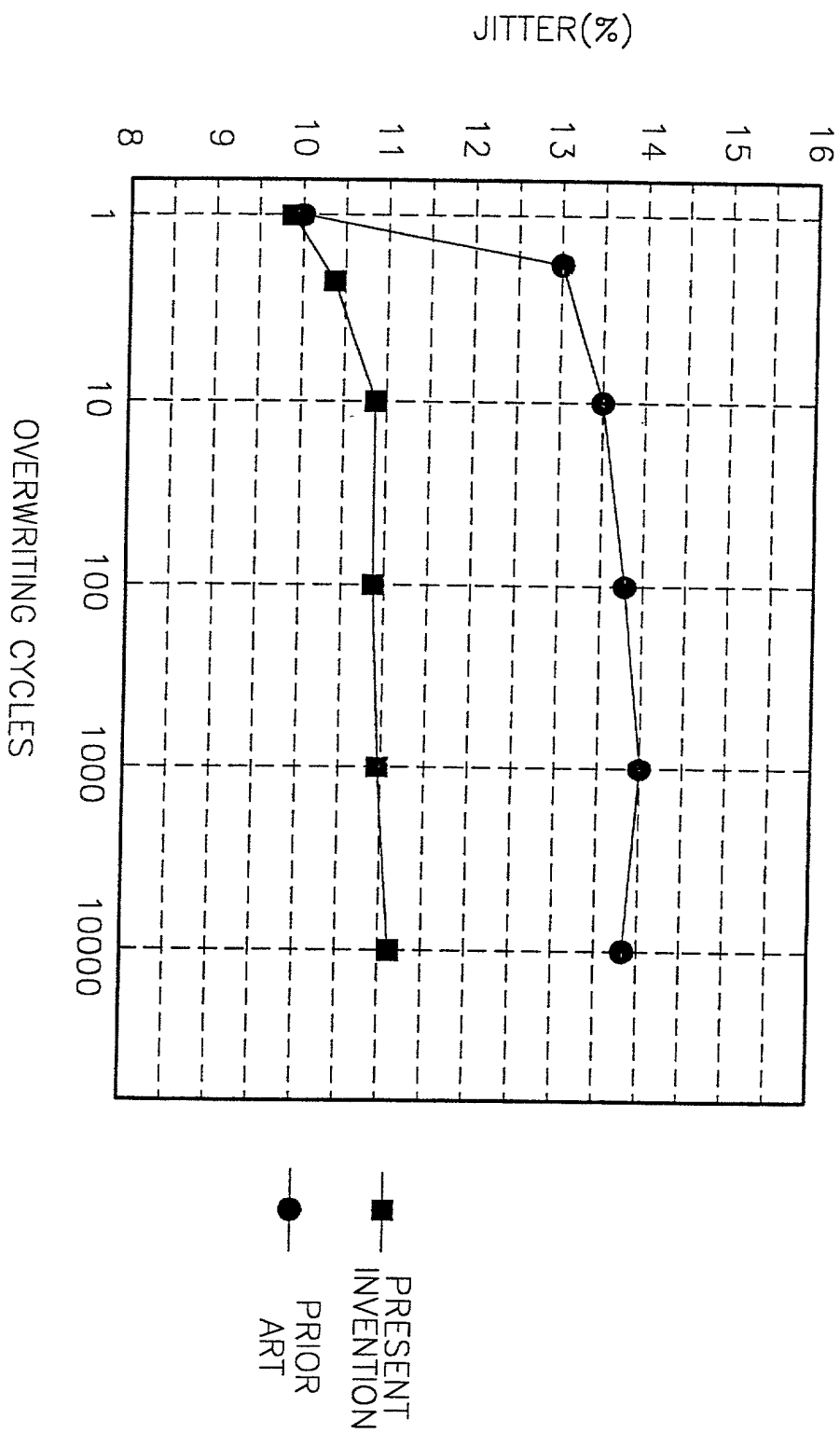


FIG. 9



COMBINED DECLARATION/POWER OF ATTORNEY FOR UTILITY/DESIGN PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

ADAPTIVE WRITING METHOD FOR HIGH-DENSITY OPTICAL RECORDING APPARATUS AND CIRCUIT THEREOF

the specification of which is attached hereto, unless the following box is checked:

☒ was filed on July 23, 1999 as United States Application Number or PCT International Application Number 09/359,128 and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56.

I hereby claim foreign priority benefit(s) under 35 U.S.C. § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

Priority Not Claimed

<u>98-29732</u> (Number)	<u>Korea</u> (Country)	<u>23/July/1998</u> Day/Month/Year Filed	<input type="checkbox"/>
<u>97-77746</u> (Number)	<u>Korea</u> (Country)	<u>30/December/1997</u> Day/Month/Year Filed	<input checked="" type="checkbox"/>
<u>98-4071</u> (Number)	<u>Korea</u> (Country)	<u>11/February/1998</u> Day/Month/Year Filed	<input checked="" type="checkbox"/>

I hereby claim the benefit under 35 U.S.C. § 120 or § 119(e) of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application(s) in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

_____ (Application Serial No.)	_____ (Filing Date)	_____ (Status -- patented, pending, abandoned)
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_____ (Application Serial No.)	_____ (Filing Date)	_____ (Status -- patented, pending, abandoned)
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I hereby appoint the following attorneys and agent to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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☐ Additional inventors are being named on separately numbered sheets attached hereto.